



IDENTIFICATION, COMMUNICATION AND MANAGEMENT OF RISKS RELATING TO DRINKING WATER POLLUTION IN BIHOR COUNTY

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Abstract

At global level, the microbiological quality of water is a matter of concern, since diarrhoea represents the second cause of mortality. In addition, nitrates represent a significant problem and their high concentration - above the accepted limits - in drinking water is frequently encountered in Romania. Water samples have been analyzed in accordance with the methodology recommended by The Public Health Institute Bucharest. 78.15% of the water samples evaluated during the interval 2004-2007 proved that they do not fit the quality norms. The frequency of the samples which do not meet the minimal requirements of the specific norms indicates an increasing tendency. The layered analysis of data has established ascending trajectories, inverse correlations and acceptable levels of association for both the out-of-norms microbiological samples and the physical-chemical. Despite the fact that the pollution of the drinking water supplied by public distributing stations has become more intense, the frequency of acute water-related diarrhoeal illnesses and of infantile methemoglobinemia is often underestimated.

Key words: acute diarrhea, chemical pollution, microbiological pollution, , cyanotic infantile methemoglobinemia.

1. Introduction

Drinking water is an essential environmental constituent, with a major impact upon the quality of life and the health state of the population. There are speculations that associate the modern civilization with the rediscovery of hygiene, rather than with the industrial revolution.

Drinking water is intended to be ingested by humans: the phrase "drinking water" refers to any type of water, either treated or in a natural state, which is used for drinking, cooking or any other domestic purposes, regardless of its origin or whether it is supplied by distribution stations, provided in water tanks or stored in bottles or other containers; the words "drinking water" also refer to other types of water, used as material by the food industry (Law 458, 2002).

Drinking water must be healthy and clean, meeting the following demands: it should not contain microorganisms, parasites or substances that might represent a potential hazard for human health and it must meet the minimal requirements stipulated in

Law 458 (2002), concerning the quality parameters of potable water (microbiological, chemical and indicators).

Water pollution refers to a change in the natural qualities of water as a result of its contamination with external elements, to an extent that makes it unsuitable for use and ingestion; it can be the consequence of natural phenomena, but most frequently it appears as a result of human activity. The specific pollutants that can have negative effects upon the health state of the population (injury, disease or death) represent risk factors and can be grouped in the following categories: microbiological pollutants (bacteria, viruses, parasites) and chemical pollutants (toxic chemical substances). They can be identified and their level of toxicity and particular effects can also be established (Manescu et al., 1996; Popa, 2001).

Recent statistics indicate that the infectious hydric pathology has marked an ascending trend, and is chiefly the result of polluted water ingestion. The infectious diseases caused by water intake continue to make around 25 000 victims in the whole world every

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day. Though water ingestion is the main cause of infectious diseases, people can also be contaminated while washing, bathing or inhaling water vapors (<http://www.greenagenda.org/eco-aqua/potabil.htm>, 2008).

The microbiological quality of water is decreasing in many countries. The bacterial diarrhoea, which can be caused both by water ingestion and the absence of water (when the norms of individual hygiene are not observed), continue to represent a threat for public health, even in developed countries. At global level, diarrhoea occupies the second place among mortality causes, after the cardiovascular diseases, and studies conducted in many countries conclude that the incidence of this disease is highly underestimated. Its recent evolution is disturbing, since 2 million children die every year due to water-related diarrhoeal illnesses, and the annual number of people becoming ill with such diseases is of about 900.000.000 (<http://www.greenagenda.org/eco-aqua/potabil.htm>, 2008; Ionut, 2004).

Part of the toxic chemical substances that can be transmitted through water ingestion have their origin in nature, but their large majority result from the pollution of aquifers (<http://www.greenagenda.org/eco-aqua/potabil.htm>, 2008). Nowadays, at both the global and the local level, pollution accidents in punctual and non-punctual sources represent a frequent cause of chemical contamination of water, with possible acute or chronic consequences upon the health of the population living in the contaminated area. The water-related illnesses, especially the ones associated with the ingestion of contaminated water, continue to represent a problem of public health; more and more studies emphasize the connection between the chemical pollution of potable water and the creation of favorable circumstances for maladies such as cancer, congenital malformations, endocrine disruptions, acute and chronic intoxications (<http://www.ara.ro/apa%20curata>).

Nitrates, which are toxic chemical elements that indicate an older pollution, can represent a major problem since their concentration in water, above the accepted limits, is frequently encountered in our country. Nitrites, resulting from the reduction of nitrates either before consumption or in the lumen of the digestive tract, cause cyanotic infant methemoglobinemia, which affects people at very young ages, and sometimes even at adulthood. Our country presents a high incidence of methemoglobinemia, with a significant mortality, this illness being much underestimated, given the difficulty of diagnosing it. Nitrates may be found in human or animal excrements, but their presence in water can also be associated with the large-scale use of fertilizing substances in agriculture (<http://www.greenagenda.org/eco-aqua/potabil.htm>, 2008; Ionut, 2004; Laza and Ionut, 2001; Popa, 2001).

In Romania, a certain percentage of water sources should not be used, but people's ignorance or the absence of alternatives determines the use of water from inadequate wells and springs.

The aim of this study is to evaluate the quality of the potable water supplied by public distributing stations (central systems and public wells) in Bihor County between 2004 and 2007, and to analyze the effects of pollution on people's health.

2. Materials and method

The probe sampling has been done in accordance with the methodology recommended by The Public Health Institute, Bucharest, the samples being periodically collected from the water treatment plant, from along the water-supply network and from the consumers' taps.

The interpretation of results has been achieved by means of their correlation with the sanitary regulations (Table 1), while data analysis has been completed with the help EPIINFO6 and EXCEL statistical programs. The control of drinking water quality has been continually and permanently carried out in the laboratories of the water plant and in the Public Health Authority laboratory of Bihor County.

Table 1. The quality parameters of drinking water (extract from Law number 458, 2002 - Appendix 1)

<i>Parameter / Units</i>		<i>Accepted value</i>
<i>Microbiological parameters</i>	Escherichia coli (E. Coli)/100 mL	0
	Enterococci (Faecal streptococci)/100 L	0
<i>Chemical parameters</i>	Ammonium (mg/L)	0.50
	Nitrates (mg/L)	50
	Nitrites (mg/L)	0.50

3. Results and discussions

During the period of research, 4254 water samples were drawn; of this total, 2218 proved inadequate, the microbiologically inadequate ones being predominant (64.9% from the total of inadequate samples and 33.9% from the total of gathered samples) (Fig. 1).

The annual evolution of the relative frequency of the total inadequate samples marked a clear upward trend between 2004 and 2006 (increasing with 73.97%); when attention is focused upon the last year, and a comparison is made with 2006, a decrease in the percentage of the inadequate samples can be observed, though this percentage continues to present values that are superior to the first two years of research (Figs. 2, 3). The percentage of physical-chemical inadequate samples presented a growing tendency during the first three years of the period under investigation (showing an increase with 30.26%), but a decrease with 29.46% can be observed in the last interval that was evaluated.

Since only one hydric epidemic was registered during the period under investigation, in 2006, the study proceeded to the research of acute infectious diarrhea cases, recorded during the period mentioned above.

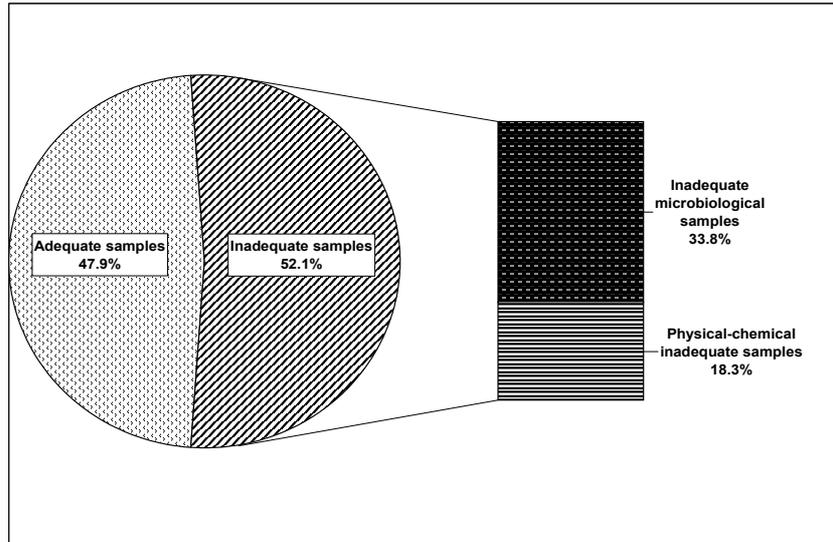


Fig. 1. The relative frequency of samples

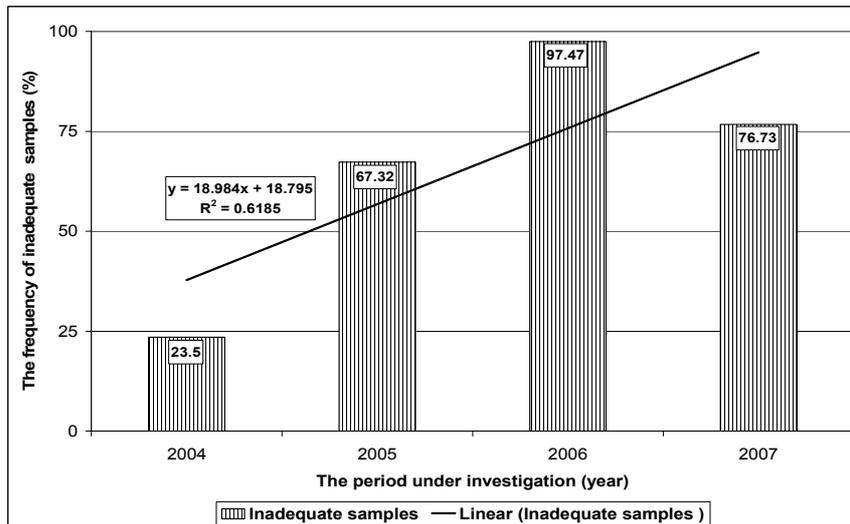


Fig.2. The annual evolution of the relative frequency of the inadequate samples

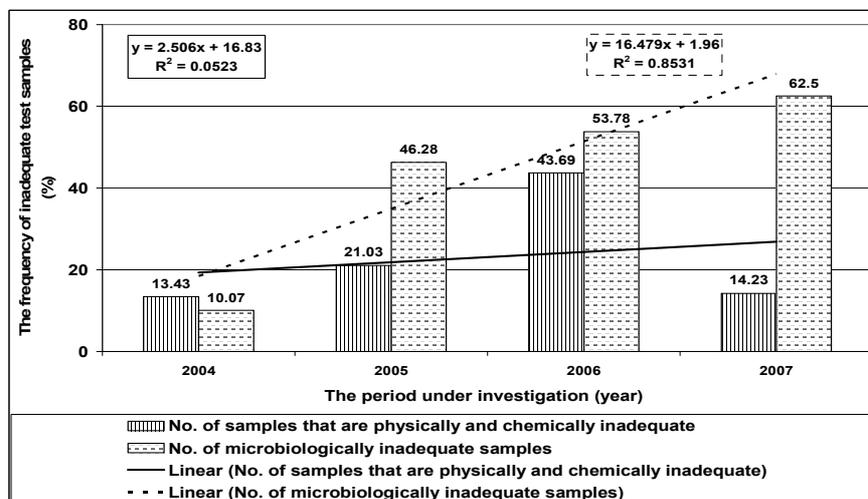


Fig. 3. The annual evolution of the relative frequency of the inadequate sample types

Between 2004 and 2007, a number of 13,682 cases of acute diarrhea have been recorded, this illness being the most frequent among health problems caused by the ingestion of microbiologically contaminated water (3,717 in 2004; 2,911 in 2005; 3,724 in 2006 and 3,330 in 2007).

The regression and correlation analysis indicates an inverse correlation and a moderate association level ($r = -0.659$) between the number of persons taken ill by the ingestion of contaminated water and the number of microbiologically inadequate samples (Fig. 4).

The determination coefficient $R^2 = 0.4351$ suggests the fact that the variation in the number of acute diarrhea cases can be explained, in proportion of 43.51%, through the linear relationship which exists between this coefficient and the number of the microbiologically polluted test samples, while the rest of 56.49% corresponds to an unexplained or residual variability (disease caused by contaminated food, direct contact with ill persons or an unreal number of persons who were taken ill). During the period of investigation, a number of 4 cases of cyanotic infantile methemoglobinemia, caused by ingestion of water coming from public wells, have been registered.

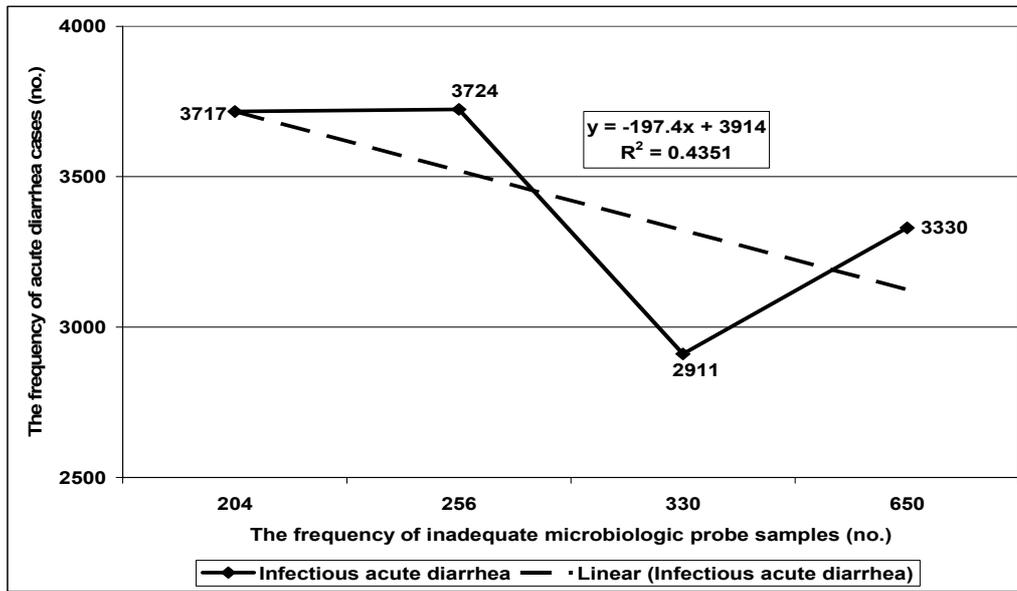


Fig. 4. The evolution of the acute diarrhea in relation with the frequency of microbiologically contaminated samples

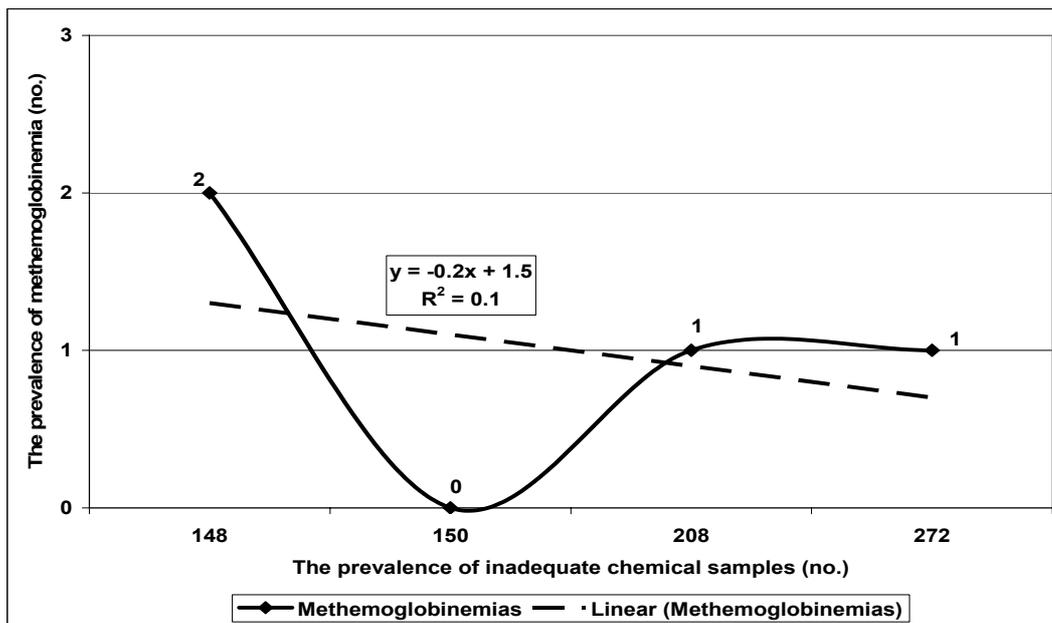


Fig. 5. The evolution of infantile cyanotic methemoglobinemia in relation with the frequency of samples inadequate from the physical-chemical point of view

The regression and correlation analysis indicates an inverse correlation and an acceptable association level ($r = -0.316$) between the number of patients taken ill and the number of samples that are inadequate from the physical and chemical point of view (Fig. 5).

The determination coefficient $R^2 = 0.1$ indicates the fact that the variation in the cyanotic infant methemoglobinemia occurrence rate can be explained, in proportion of 1%, by the linear relation that exists between this factor and the number of the chemically polluted samples, while the remaining 99% corresponds to an unexplained or residual variability (disease caused by the ingestion of polluted water coming from other sources or an inaccurate number of persons taken ill).

The negative correlation coefficients might suggest the fact that the intensification of microbiological and chemical pollution of water sources could have determined the decrease in the number of both acute diarrhea cases and cyanotic infantile methemoglobinemia, which is a very unlikely situation. This particular aspect and the high residual variations indicate the fact that there is no linear correspondence between the number of the above-mentioned illnesses and the prevalence of inadequate samples.

The control of potable water supply systems indicates a series of deficiencies: the inadequate quality of water at source (which presents a high quantity of ammonium and nitrites), the inefficient maintenance of water-intake works and of purifying plants, the empirical procedure used for water purification, outdated and inadequate, or even unavailable disinfection equipments, the intermittent distribution of water, the absence of sanitary protection areas or the inadequate hygienic maintenance of these areas, the existence of disintegrated, outworn or undersized water supply networks, the disregard for the hygienic and sanitary norms concerning the maintenance of water tanks.

4. Conclusions

With regards to the quality of the potable water provided to consumers in Bihor County between 2004 and 2007, the following can be concluded:

1. The chemical and microbiological pollution of water has been constant and intensive, an improvement - from the physical and chemical point of view - being observed in the last year of the period focused upon;

2. There are no linear relations between the number of inadequate samples and the number of people taken ill as a result of the ingestion of polluted water (acute diarrheas or cyanotic infantile methemoglobinemia). Accountable for such results is either the underestimation of the number of cases of the two diseases mentioned above (this situation may be the result of an absence of information on the one

hand, and of the absence of reports concerning the actual number of diseases caused by water ingestion on the other hand) or the replacement of the drinkable water that is supplied by public distributing stations with bottled water – still or carbonated mineral water, or different other beverages.

3. The absence of eco-technology in rivers and water catching protection areas, which continuously causes the pollution of water resources.

4. The technologic equipments available in water plants are incompatible with the water quality complex, while the difficulties related to the running of water plants and to the supply of quality water is accentuated by over-production, the absence of current or capital repairs or by the need to replace equipments.

5. Among the most important situations accountable for the contamination of potable water with nitrates, the inadequate agricultural activities and the absence of hygienic conditions can be mentioned. Despite the attempts to replace some elements of the distribution system, the recurrent interventions continue to contribute substantially to the decrease in the quality of water that is supplied to consumers in Bihor county.

Since regulations referring to water quality are often ignored, the resulting drawbacks should be identified and coercive measures should be put into practice as soon as possible, in order to obtain drinking water of a better quality. If necessary the distribution of water should be restricted or even ceased.

For the time being, since it is impossible to ameliorate the properties of underground water, before it is introduced into the system of potable water distribution, the only solution for the improvement of potable water quality is its dilution with the water produced in already existing water plants.

Current legislation stipulates the necessity to provide consumers with adequate and updated information concerning the quality of potable water. Accurate information with regards to the quality of water will probably increase people's awareness with respect to the importance and the role of water for human health.

In this context, the *risk management* and implicitly the assurance of water biostability while it is being transported, stored or distributed, requires the following:

- The production of a type of water that can maintain its initial quality at consumers' taps, without being transformed by the condition of the external or the internal distribution system;
- The proper maintenance of water distribution systems, in order to preserve the quality of water, which requires a standing water pressure, the detection and reduction of water losses, the control of the process of sedimentation and corrosion of materials that are used in water distribution systems,

and the use of new materials (PE, thermoplastic resins, composite materials);

- The building of data bases that facilitate the identification of optimal solutions for the problems that might appear in the system;
- The information of population with regards to hygienic measures, which are necessary for the prevention of hydric pathology.

The increased exigency of consumers with reference to potable water, alongside the rise of prices, accentuates the problem of water quality.

The main objectives related to the supply of drinking water in Bihor County refer to:

- ✓ The surveillance of European standards concerning the quality of water, the assimilation of a the quality management system and the availability of adequate water treatment technologies;
- ✓ The reduction of operation costs, by updating the techniques of exploitations and by implementing the principles of efficient management;
- ✓ Minimizing specific consumption (of electric energy and reactive substances) through the use of new technologies, the building of a functional pipe systems, and the provision of automatic and common equipment systems;
- ✓ The permanent supply of all consumers with water, the reduction of water losses, and the increase of potable water production.

A more efficient coordination between institutions that are responsible for the quality of water is imperative in order to create the context for a more complex research activity and a scientific approach to the improvement and upgrading of water distribution networks and water plants in Bihor county.

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